AN OPTICAL COUPLING SYSTEM

BACKGROUND

The invention relates to optical devices and more particularly to devices for providing coupling between optoelectronic elements and optical fiber.

Several patent documents may be related to optical coupling between optoelectronic elements and optical media. They include U.S. Patent No. 6,086, 263 by Selli et al., issued July 11, 2000, entitled "Active Device Receptacle" and owned by the assignee of the present application; U.S. Patent No. 6,302,596 B1 by Cohen et al., issued October 16, 2001, and entitled "Small Form Factor Optoelectronic Receivers"; U.S. Patent No. 5,692,083 by Bennet, issued November 25, 1997, and entitled "In-Line Unitary Optical Device Mount and Package therefore"; and U.S. Patent 6,536,959 B2, by Kuhn et al., issued March 25, 2003, and entitled "Coupling Configuration for Connecting an Optical Fiber to an Optoelectronic Component"; which are herein incorporated by reference.

In the context of the invention, the optoelectronic element may be understood as being a transmitter or a receiver. When electrically driven, the optoelectronic element in the form of a transmitter converts the electrical signals into optical signals

that are transmitted in the form of light signals. On receiving optical signals, the optoelectronic element in the form of a receiver converts these signals into corresponding electrical signals that can be tapped off at the output. In addition, an optical fiber is understood to be any apparatus for forwarding an optical signal with spatial limitation, in particular preformed optical fibers and so-called waveguides.

Fiber optic receptacle designs of the related art having sleeves use a fiber optic stub or other precision diameter devices or inserts to mechanically hold a sleeve in position. This method of mechanically mounting the sleeve prevents certain types of optical designs from being implemented.

In the related art, the standard single mode optical receptacle design may use various implementations of structure in conjunction with a fiber stub/pig-tail. However, since the stub/pig-tail is expensive and fragile and/or difficult to handle, a stub-less approach would be desirable.

SUMMARY

The present invention may fulfill the desire for a stub-less receptacle design. An instance of the invention optical coupling system may include a support structure, a holding

structure attached to said support structure and an optical medium holder held by the holding structure. The holding structure may have a sheet or layer of material shaped so as to semi-enclose the optical medium holder. The sheet or layer of material may apply a pressure of contact at least partially around on the optical medium holder. There may be an optoelectronic element holder attached to the support structure. The optical medium holder and optoelectronic element holder may need a certain alignment relative to each other. The holding structure may maintain the certain alignment of the optical medium holder with the optoelectronic element holder with virtually no wiggle. The sheet of material may be a sleeve having a slit. The optical medium holder may have an outside diameter slightly larger than an inside diameter of the sleeve with the optical medium holder not in the sleeve. The inside diameter of the sleeve may be expanded against a spring-like tension to a size of the outside diameter of the optical medium holder with the optical medium holder in the sleeve. The optical medium holder may hold an optical fiber and the optoelectronic element holder may hold a light source. The light source may be a laser, and more specifically may be a vertical cavity surface emitting laser. The optical fiber may

be a single mode fiber. The holding structure may maintain a certain alignment between an end of the single mode fiber and the vertical cavity surface emitting laser. In other words, the sleeve expands with flex-like resistance upon an insertion of the optical fiber ferrule and holds the ferrule in position relative to the barrel in a consistent and essentially centered position within the sleeve so as to maintain the established optical alignment of the mated elements. Instead of a light source, the optoelectronic element holder may hold a detector.

An instance of the present system may involve a split sleeve available from certain vendors. Such item may be inexpensive (less than one U.S. dollar in year 2003). In the split sleeve approach, a strip of metallization may be applied to the outside surface along a length of a zirconia split sleeve opposite of the slit. The metallization may be fired on the sleeve using one of several available metallization techniques. The sleeve may be secured at the area of metallization in position relative to metal receptacle housings or coupler barrels with standard metal-to-metal joining techniques such as solder or brazing or alternatively, a non-migrating adhesive. Many other techniques and materials may be used for assuring secure attachment of the sleeve to the housing or barrel. An

advantage of the metallization technique may be that the metallization patch defines the surface area of the sleeve to be bonded so that only the desired area is attached. Moreover, since this patch area may be reasonably accurately defined and controlled by standard masking/patterning techniques, this may result in consistent mechanical joint characteristics. In contrast, a downside with using an adhesive is that some adhesives might migrate resulting in variable joint contact area or even a slight shift of the sleeve relative to the housing or the barrel to which it would be attached. This shift may degrade the alignment of the fiber of the ferrule with the laser source, photo detector, or other optoelectronic element. A true non-movement of the sleeve after attachment at the bonding path to the receptacle or barrel is important so that the zirconia split sleeve does not affect overall alignment. The split sleeve may need to flex in order to hold a fiber optic ferrule firmly in the appropriate position. With this approach, precise alignment of the ferrule held by the zirconia split sleeve in the fiber optic receptacle may be achievable. This manner for attaining a fixed location of the fiber or medium in the receptacle or barrel may prevent wiggle of the ferrule and

maintain precise alignment of the ferrule with the optoelectronic element in the optical assembly.

DESCRIPTION OF THE DRAWING

Figure 1 is an exploded perspective view of an optical coupler incorporating the split sleeve used to hold a ferrule firmly in place in the coupler.

Figure 2 is a group of aligned plan views of the split sleeve used in the coupler of Figure 1.

Figures 3a and 3b are perspective views illustrating the split sleeve of Figure 2.

Figure 4 is a cross-section view of the optical coupler at about the end of the ferrule.

DESCRIPTION

Figure 1 shows an optical assembly 10 which may be utilized for coupling an optical fiber 11 with an optoelectronic element 21 of package or housing 12. Housing or package 12 holding element 21 may fit into or onto a z-axis alignment sleeve 13. Alignment sleeve 13 may be secured to housing 12 with a weld or an adhesive. Or housing 12 and alignment sleeve 13 may be machined so that they may have threads about their inside and

outside circumferences, respectively, and be screwed together. An alternative approach would be for sleeve 13 to be press fit to housing 12. Sleeve 13 may be slipped onto or in the end 14 of a metal barrel 15. Within sleeve 13 and barrel 15 may be an optical subassembly 16. Subassembly 16 may include a ball lens optical arrangement for focusing the sensing or emitting element 21 with an end 19 of optical fiber 11 at the center of the base of a ferrule 20. The optics of assembly 16 may include some other arrangement such as one incorporating an aspheric lens. A zirconia split sleeve 18 may be inserted in a portion 22 of barrel 15. Ferrule 20 may be inserted into split sleeve 18. Alignment sleeve 13 may be slipped into or onto portion 14 of barrel 15. The z-alignment of element 12 may be adjusted in terms of its distance from core end 19 of fiber 11 along the longitudinal or z axis 33 of assembly 10. Upon appropriate adjustment of sleeve 13 relative to portion 14 of barrel 15, sleeve 13 may be fixed to portion 14 with a weld or some other securing mechanism. It may instead involve a set of machined threads on sleeve 13 that fit a set of threads in portion 14. Then sleeve 13 may be screwed into portion 14 for the adjustment and securing of sleeve 13, housing 12 and optical assembly relative to barrel 15.

Split sleeve 18 is significant part of assembly 10 as it may provide for maintaining an x and y alignment of fiber end 19 with device 21 of element 12. It may be the structure of split sleeve 18, the manner of mounting the sleeve and the way it holds ferrule 20 which may provide a virtually wiggle-free securing of ferrule 20 for the maintaining the alignment of fiber core end 19 with optoelectronic element 21 of housing or package 12. Split sleeve 18 may bias ferrule 20 to one side of the sleeve with a spring-like force on ferrule 20 to that side. Thus, if the ferrules 20 used in sleeve 18 vary somewhat in size or diameter, they may all be hold-able by sleeve 18 in a firm position or location relative to the sleeve. This tension of holding ferrule 20 in place may prevent wiggle of ferrule 20 in the optical coupler assembly 10 so long as sleeve 18 is firmly attached to barrel or housing 20. The latter may made of a metal. The inside diameter of split sleeve 18 may be slightly smaller than the outside diameter of ferrule 20. Thus, the stretching of sleeve 18 needed to allow the insertion of ferrule 20 in sleeve 18 may result in a spring tension on ferrule 20 by split sleeve 18. During the insertion of ferrule 20 into sleeve 18, slit 25 of sleeve 18 may become wider to accommodate a slightly larger ferrule inside of sleeve 18. Split sleeve 18

may be made from a zirconia ceramic material. This material may be exceptionally hard. It also may be dimensionally stable over temperature changes. The zirconia ceramic may be springy and may be precisely machined. Ferrule 20 may be made of the same material as that of sleeve 18. Thus the coefficients of thermal expansion of sleeve 18 and ferrule 20 may be approximately the same.

Figure 2 shows four views 18a, 18b, 18c and 18d of an illustrative example of zirconia split sleeve 18. View 18a is an end view of sleeve 18 that reveals the radii of an inside surface 23 and outside surface 24. There may be a slit or space 25 in sleeve 18 which amounts to about 15 degrees of the circumference of sleeve 18 and extends about the length of sleeve 18 as shown in view 18b. An example sleeve 18 may be ordered from Toto Ltd. in Japan at www.toto.co.jp. There may be two versions of the sleeve, that is a mini split sleeve and a standard split sleeve. The mini split sleeve may have an inside diameter from about 1.240 to about 1.245 mm and an outside diameter of about 1.6 to about 1.7 mm. This sleeve may have a length between about 5 and 7 mm. The slit width may be about 0.2 mm. The pull-out, withdrawal or extraction force may be between about 1 and 3 N for standard specification zirconia

ferruled fibers. The standard split sleeve may have an inside diameter from about 2.490 to about 2.495 mm and an outside diameter of about 3.2 to about 3.4 mm. The sleeve may have a length between about 5 and 13 mm. The slit width may be about 0.5 mm. The pull-out, withdrawal or extraction force may be between about 2 and 6 N. On the surface of sleeve 18 directly opposite from slit 25 may be a metallization layer 26 on outer surface 24. Layer 26 may cover about 45 degrees of the circumference of surface 24 and be about the length of sleeve 18 as shown in view 18c. The thickness of metallization layer may be about 0.005 mm (0.0002 in.). View 18d shows sleeve 18 from the side with the metallization surface facing downward. The edges 27 of sleeve 18 may have a rounded outer edge and a beveled inside edge. The outside diameter of a mini ferrule may be about 1.25 mm and the standard ferrule may be about 1.5 mm. The diameter of the hole for fiber core 19 is about the size of the outside diameter of the fiber.

Figure 3a is a perspective view of sleeve 18 showing slit 25. Figure 3b is another perspective view of sleeve 18 showing metallization strip 26 on outer surface 24 opposite of slit 25.

Figure 4 is a cross-section view at about the fiber core end 19 and looking at the end surface of ferrule 20. This

Figure is not drawn to scale. Sleeve 18 may be secured and brazed to barrel 15 in portion 22 at metallization 26 area. As ferrule is inserted into sleeve 18, it may flex, spring or stretch out sleeve 18 and slightly widen slit 25. Since sleeve 18 may tend to return to its original shape, tension may be maintained on ferrule 20 by sleeve 18 at points or surfaces 28 and 29 at about the inner edges of slit 25, and at point or surface 30 opposite of slit 25. The three places 28, 29 and 30 of contacts under pressure between sleeve 18 and ferrule 20 may firmly hold ferrule 20 in one position relative to sleeve 18 and barrel 15. Thus, there would appear to be no wiggle or movement, particularly in the x direction or axis 31 and the y direction or axis 32 (perpendicular to the longitudinal axis or z alignment direction 33) of ferrule 20 and fiber core 19 relative to sleeve 18, barrel 15 and optoelectronic element 21 in package 12. This may result in the precise location of core 19 center of a pluggable device, tip or ferrule 20 after plug-in, which may be actively be aligned to element 21 and/or coupling optics appropriate to a design application. The achieved precise alignment may be retained. This coupling arrangement may be done in one and two dimensional arrays.

Although the invention has been described with respect to at least one illustrative embodiment, many variations and modifications will become apparent to those skilled in the art upon reading the present specification. It is therefore the intention that the appended claims be interpreted as broadly as possible in view of the prior art to include all such variations and modifications.